Trade-offs underlying maternal breastfeeding decisions: A conceptual model

Kristin P. Tully, Ph.D. and Helen L. Ball, Ph.D.

Kristin P. Tully is a Postdoctoral Fellow with the Carolina Consortium on Human Development through Duke University, Durham, North Carolina. She is an Associate of the Carolina Global Breastfeeding Institute, University of North Carolina at Chapel Hill. Helen L. Ball is a Professor in the Department of Anthropology, and Fellow of the Wolfson Research Institute, Durham University, Durham, UK. Kristin and Helen are also members of the Durham University Parent-Infant Sleep Laboratory, Queen's Campus, Stockton-on-Tees, UK.

Correspondence

Kristin P. Tully, Postdoctoral Fellow, Center for Developmental Science, 100 East Franklin Street, Suite 200, Campus Box 8115, Chapel Hill, North Carolina, 27599 (e-mail: Kristin.Tully@duke.edu, tel: 001-330-495-5661, fax: 001-919-966-4520)

Helen L. Ball, Professor, Department of Anthropology, Durham University, Dawson Building, South Road, Durham, DH1 3LE, United Kingdom

Contributions

K.P Tully conceived the model while conducting doctoral research with the supervision of H.L. Ball. Both authors helped to formulate ideas, K.P. Tully led the writing, and both authors reviewed drafts of the manuscript.

Acknowledgements

The authors thank Diane Holditch-Davis, Daniel Belsky, and Eric A. Hodges for helpful comments on a previous draft of this manuscript.

Introduction

Infant feeding has required extensive maternal time and energy throughout mammalian, primate, and hominin existence. Breastfeeding is a dynamic process comprising regulation between the mother's and infant's interconnected physiological, psychological, and behavioral systems (Winberg 2005). Lactation can be understood as the final stage of labor (Labbok 2001) and as the physiological completion of the woman's current reproductive cycle (Lawrence and Lawrence 2005).

Despite the importance for child health, exclusive breastfeeding is globally rare (WHO 2010) and this carries a huge disease burden (Hauck et al. 2011; Black et al. 2008; Horta et al. 2007; Labbok et al. 2004). Current costs of suboptimal breastfeeding related to pediatric disease in the United States are estimated to be billions of dollars and hundreds of lives per year (Bartick and Reinhold 2010). Although there are continual improvements in the composition of formula, human milk is biologically superior and clinically optimal in the vast majority of circumstances (WHO 2009). The American Academy of Pediatrics confirms that all infant feeding substitutes differ "markedly" from the species-specific human milk (2005, p. 496).

In an evolutionary framework, breastfeeding benefits mothers because it promotes the health of their offspring and themselves. In addition to the parental gratification that can be conferred through the breastfeeding relationship (Rempel and Rempel 2010; Dykes and Flacking 2010), lactation has short- and long-term physical effects on the mother (Stuebe and Schwarz 2010; Blackburn 2007), including delayed resumption of fecundity (Bellagio Consensus Statement 1988; Valeggia and Ellison 2009). Infant feeding plays a vital role in maternal and child health, yet there is low adherence to medical recommendations and personal goals are often unrealized. Many women who intend to breastfeed supplement with formula or terminate breastfeeding in the early postpartum period (McQueen et al. 2011; Declercq et al. 2009; Grummer-Strawn et al. 2008; Lavender et al. 2005). Recognition of possible asymmetries in the costs and benefits between the dyad may be key for enabling better initiation rates and facilitating maintenance of the breastfeeding relationship.

Infant feeding is among the most intensive aspects of parenting, so maternal strategies for breastfeeding will be adopted in ways consistent with expectations of payoffs (Tracer 2009). Strategies are embedded within cultural expectations, affected by environmental constraints, and influence many aspects of families' lives (Lavender et al. 2006). Not surprisingly, parental attitudes are increasingly identified in the literature as central to

breastfeeding outcomes (e.g., Bai et al. 2010; Dyson et al. 2010; Wojcicki et al. 2010), as are hospital practices that affect maternal access to newborns, and women's views towards infant feeding (e.g., Abrahams and Labbok 2009; Cramton et al. 2009; Declercq et al. 2009; Bartington et al. 2006; Merten et al. 2005). Many women report having both positive and negative feelings about breastfeeding (Andrew and Harvey 2011; Forster and McLachlan 2010), which suggests that mothers continually perform 'balancing acts' with infant feeding.

Frequent breastfeeding is biologically appropriate for infants due to their small stomachs and the low solute composition of human milk (Blackburn 2007). However, this is associated with fragmented maternal sleep (Tikotzky et al. 2010), which is a major concern of many parents (Sadeh et al. 2011). Feeding occupies a large proportion of the infant's waking time and much of early mother-infant interaction. Therefore, the feeding experience has consequences for the dyad's overall relationship (Pearson et al. 2011). Similarly, mother-infant interactions have consequences for the feeding experience, such as assessment of and response to infant cues regarding hunger and satiety. Thus, infant feeding trade-offs may be expected to change over time as the dyadic relationship changes, with consequences for breastfeeding outcomes.

Maternal intent plays a central, yet inadequately understood, role in breastfeeding (Nommsen-Rivers et al. 2010b). That families' prenatal ideas and reasoning affect infant feeding outcomes is well-known (Alexander et al. 2010; MacGregor and Hughes 2010; Nommsen-Rivers et al. 2010a), yet breastfeeding plans are not static. Only a few studies have begun to address the ways in which parents rework their attitudes and subsequent behavior in response to infant cues (e.g., Hodges et al. 2008; Howard et al. 2006; Mizuno et al. 2004; Mentro et al. 2002) and the changing maternal landscape (e.g., Bai et al. 2010; Burns et al. 2010; Sheehan et al. 2010). Attention to the infant feeding issues most salient to mothers has led to the recurrent Western theme of breastfeeding requiring perseverance (Burns et al. 2010) because the process can involve over-coming or circumventing psychological, practical, and social obstacles (Stewart-Knox et al. 2003). Overall, decision criteria for the initiation of breastfeeding may often be very different than reasons for its maintenance (Rothman 2000).

Evolutionary life history theory predicts that – whether consciously or not – organisms prioritize resources based on predicted costs and benefits over their lifespan. This is ultimately because growth, maintenance, and reproductive effort are sometimes conflicting pursuits (Bentley 2007). Reiches et al. (2009) summarize this 'energy budget':

> It is adaptive to commit to these expenditures only when prospects for success are reasonable and only to a degree that optimizes lifetime reproductive success (p. 442).

The prediction is that animals, including humans, will preferentially invest in close relatives, individuals with perceived high potential for future reproduction, and those who incur relatively low costs (Strassman and Mace 2008).

Parents and offspring inherently confront some conflicts of interest because offspring only share a portion of their parent's genes. The infant strives to be as healthy as possible without draining the caregiver to a degree that she/he can no longer invest; the parent strives to raise healthy offspring that survive to reproduce at a minimal cost (Vitzthum 2008; Haig 1993, 2008; Trivers 1974; Darwin 1871). These parent and infant strategies are largely subconscious – they are not scheming to take advantage of one another (Tracer 2009). Rather, these cognitive and behavioral patterns were selected over the course of evolutionary history to optimize inclusive fitness. This facultative or contingent response has been analyzed in relation to infant feeding by various anthropologists, including Scheper-Hughes (1992), McDade and Worthman (1998), Ball and Panter-Brick (2001), Worthman and Kuzara (2005), and Sellen (2007). Mothers have the option of expending a portion of their finite time and effort towards breastfeeding, or they can employ alternate pathways for infant feeding such as human milk substitutes, donor human milk, wet nurses, and/or lack of engagement.

The model we propose below is a tool to conceptualize inherent breastfeeding trade-offs and to illustrate how this balance can be altered by exogenous and endogenous factors. Our approach is consistent with the situation-specific theory of breastfeeding (STB) (Nelson 2006) in that balancing is modeled as occurring within the mother-infant dyad and between the dyad and their broader network of relationships:

> Simultaneous consideration of the parts and the whole, that is, the individual mother/infant dyad and the broader breastfeeding context, is necessary, as is attention to our approach to breastfeeding interventions and examination of our perceptions of the professional role (p. 23).

We integrate parent-offspring conflict theory and the STB to assist in the construction of questions and methods to better understand the multi-directional influences that contribute to women's strength of breastfeeding intent and the continual feedback affecting their perseverance.

Model

Figure 1 expands the parent-offspring conflict model put forth by Trivers (1974) to illustrate breastfeeding costs and benefits among individual dyads over a specific period of time. This model illustrates that trade-offs underlie infant feeding decisions (investment) and this figure enables predictions based on marginal returns (the degree to which breastfeeding is 'worth it,' given the context).

[Figure 1 here]

The degree of investment, comprising both time and effort, that a mother could devote to breastfeeding a particular infant is portrayed on the X-axis. The benefits to the infant and the costs to the mother of the various degrees of breastfeeding input are depicted by the Y-axis. The variables in this model are defined by the mother's perceptions of the benefits and costs in addition to the physical effects. The way in which units are measured would depend on the defined time period (investment over hours, weeks, years, etc.) and on the scope of benefits and costs measured (physiological regulation, health outcomes, satisfaction, etc.). Although Trivers conceptualized parental investment as encompassing the feeding of young, in his model cost was only gauged in relation to inclusive fitness (ability to raise offspring who, in turn, reproduce). This new model therefore applies the concept to the specific investment of breastfeeding.

Figure 1 illustrates the marginal cost and benefit of various levels of breastfeeding investment over a defined time. The main point is that over a certain period, *ceteris paribus*, the optimum investment is at I_1 for the mother but it is at the greater level of I_2 for the infant. This model holds for circumstances in which no medical breastfeeding contraindications exist (e.g., AAP 2005; WHO 2009).

The absence of maternal investment results in zero benefit to the infant because (for the sake of simplicity) the model assumes that maternal time and energy invested is 'measured' in terms of human milk ingested, which is advantageous for the infant. Maternal cost does not intercept the Y-axis at zero due to the physical benefits that lactation provides for women. Maternal benefit is built into the model, in that a change in maternal cost represents an equal but opposite change in maternal benefit. The bio-psycho-social context in which breastfeeding occurs interacts to create different slopes, and therefore different optima, for individual dyads. Yet, for all applications there is theoretically a peak in the benefit to the infant, shown in Figure 1 at B_2. Past this point he/she would not breastfeed any more beyond the particular time period if given the opportunity. Although not shown in Figure 1, the benefit to the infant would eventually curve back down if maternal costs reached a level that

resulted in maternal depletion (see Jasienska 2009), which would eventually detrimentally affect the infant's condition. For all women, there is theoretically a maximum 'profit' where the difference between benefit to the infant and the cost to herself is greatest. This point (labeled I_1 on Figure 1) is the level of maternal investment at which she is able to provide the greatest benefit to the infant at the lowest cost to herself.

Trivers (1974) contended that parents do not invest indiscriminately; both his and our models predict different optima for parent and child. With reference to Figure 1, the mother will subconsciously resist investment beyond I_1 because the additional time and effort incurs a greater cost to herself (C_2–C_1) with only modest additional benefit to her infant (B_2–B_1). This tendency arises due to subjective utility maximization in the face of uncertain outcomes in return for the investment (Sloman and Wride 2009; Salehnejad 2007).

The hypotheses generated from this model are: H1: Reduction in maternal cost (or perception of cost) promotes breastfeeding, while holding infant benefit constant. H2: Increase in infant benefit (or perception of benefit) promotes breastfeeding, while holding maternal cost constant. H3: Reduction in maternal cost and increase in infant benefit (or perceptions thereof) will be more effective than H1 or H2 in promoting breastfeeding.

Known breastfeeding influences can be modeled as shifting the model's maternal cost and infant benefit lines. For example, maternal knowledge of infant health as being improved by breastfeeding (shifts the infant benefit line upwards and right); maternal perception of infants as uninterested in feeding or that breastfeeding does not satisfy the infant (shifts the infant benefit line downward and left); maternal tiredness, latching difficulty, pain, embarrassment, perception of formula feeding as being 'easier' than breastfeeding, or advice from people important to the mother to supplement or not breastfeed (shifts the maternal cost line left); and maternal perception of lactation as providing health benefits to herself, of breastfeeding as a positive experience, or of frequent infant breastfeeding as expected and 'normal' (shifts the maternal cost line right). This list is not comprehensive; the purpose here is to suggest how conceptualizing maternal feeding experience in the form of a cost-benefit model might consolidate existing knowledge and offer testable hypotheses for the development of breastfeeding interventions.

Discussion

The conceptual model focuses on inherent trade-offs in the breastfeeding landscape and asserts that mothers repeatedly re-negotiate the balance between self and child care. Certain decisions will be conscious but many are likely to be mediated by our evolved

psychology to maximize marginal returns on investment and therefore occur semi- or unconsciously, and may be rationalized in a variety of ways.

Our model avoids needless complexity (see Foster 2010) and the simplicity of the model is advantageous because the need for balance between maternal investment and returns is clear. Defining the units of measurement when testing the theoretical predictions will require careful consideration of the questions posed. The figure complements existing venn diagrams, flowcharts, and other multi-level representations of infant feeding influences (see Sheehan et al. 2010; Labbok 2008; Nelson 2006; Hector et al. 2005 Tiedje et al. 2002; Martens and Young 1997). It builds on the stituation-specific theory of breastfeeding by offering straightforward predictions about breastfeeding decisions and outcomes under various conditions.

The choices contemporary mothers have for infant feeding methods (and constraints imposed on dyads) often lead to biologically suboptimal infant and young child feeding. Our understanding of breastfeeding outcomes may be improved by person-centered, repeated measures studies. In this way, subgroup trajectories - especially the periods of greatest vulnerability - can be identified and anticipated. Attention to the interaction of both endogenous and exogenous factors on infant feeding over time, such as prenatal expectations, childbirth events, infant cues, maternal conditions, social support, and the physical environment are essential. Our approach is consistent with the systems-perspective of the developmental science framework (Lerner et al. 2005; Magnusson and Cairns 1996; Magnusson 1988) and the concept of equifinality – that the same end state (e.g., breastfeeding outcomes) can occur through “a variety of different initial conditions and through different processes” (Cicchetti and Rogosch 1996, p. 597). Various factors are known to impact initial infant feeding decisions, but reworking of infant care motives and goals and the weight of particular factors at different time points is less well explored. This paper is our contribution to this exploration.

Conclusion

A more holistic understanding of infant feeding decisions and the dynamic nature of these cost-benefit influences over time is vital. Explicit acknowledgement of maternal, family, and broader trade-offs with breastfeeding may guide translational research, lead to more realistic prenatal breastfeeding discussions, and promote more effective postpartum support of desired infant feeding trajectories.

Our framework suggests that promoting only infant benefits, such as with the 'breast is best' public health message, without comprehensive maternal, family, institutional and other support is insufficient.

Key Messages

- Some maternal-offspring conflict is inherent within the dynamic infant feeding relationship.
- A new trade-off model is offered that generates predictions about breastfeeding decisions and identifies interactions that affect infant feeding outcomes.
- Simultaneous reduction in the costs and increase in the benefits of breastfeeding (and maternal perceptions of these) will be most effective in facilitating breastfeeding.
- Explicit acknowledgement of individual families' trade-offs with infant feeding over time may aid in the development of improved support strategies.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

References

Abrahams S.W. & Labbok M.H. (2009) Exploring the impact of the Baby-Friendly Hospital Initiative on trends in exclusive breastfeeding. *International Breastfeeding Journal*, **4**, 11.

Alexander A., Dowling D., & Furman L. (2010) What do pregnant low-income women say about breastfeeding? *Breastfeeding Medicine*, **5**, 17-23.

American Academy of Pediatrics (2005) Breastfeeding and the use of human milk. *Pediatrics,* **115**, 496-506.

Andrew N. & Harvey K. (2011) Infant feeding choices: Experience, self-identity and lifestyle. *Maternal & Child Nutrition*, **7**, 48-60.

Bai Y., Middlestadt S.E., Peng C.-Y. J., & Fly A.D. (2010) Predictors of continuation of exclusive breastfeeding for the first six months of life. *Journal of Human Lacation*, **26**, 26-34.

Ball H.L. & Panter-Brick C. (2001) Child survival and the modulation of parental investment. In: *Reproductive Ecology and Human Evolution* (ed. P. Ellison), pp. 249-266. Aldine de Gruyter: New York.

Bartington S., Griffiths L.J., Tate A.R., & Dezateux C. (2006) Are breastfeeding rates higher among mothers delivering in Baby Friendly accredited maternity units in the UK? *International Journal of Epidemiology*, **35**, 1178-1186.

Bartick M., & Reinhold A. (2010) The burden of suboptimal breastfeeding in the United States: A pediatric cost analysis. *Pediatrics*, **125**, e1048-e1056.

Bellagio Consensus Statement. 1988. Breastfeeding as a family planning method. *Lancet*, **332**, 1204-1205.

Bentley G. (2007) Environmental effects on human reproduction. In: *Evolution and Medicine: How New Applications Advance Research and Practice* (ed. R. Nesse). Henry Stewart Talks Limited, The Biomedical & Life Sciences Collection: London.

Black R.E., Allen L.H., Bhutta Z.A., Caufield L.E., de Onín M. Ezzati M., Mathers C. *et al*. (2008) Maternal and child undernutrition: Global and regional exposures and health consequences. *Lancet*, **371**, 243-260.

Blackburn S.T. (2007) *Maternal, Fetal, and Neonatal Physiology: A Clinical Perspective,* 3rd edn. Saunders Elsevier: St. Louis.

Burns E., Schmied V., Sheehan A., & Fenwick J. (2010) A meta-ethnographic synthesis of women's experience of breastfeeding. *Maternal & Child Nutrition*, **6**, 201-219.

Cicchetti D. & Rogosch F. (1996) Equifinality and multifinality in developmental psychopathology. *Development and Psychopathology*, **8**, 597–600.

Cramton R., Zain-Ul-Abideen M., & Whalen B. (2009) Optimizing successful breastfeeding in the newborn. *Current Opinion in Pediatrics*, **21**, 386-396.

Darwin C. (1871) *The Descent of Man and Selection in Relation to Sex*. Appleton: New York.

Declercq E., Labbok M.H., Sakala C., & O'Hara M. (2009) Hospital practices and women's likelihood of fulfilling their intention to exclusively breastfeed. *American Journal of Public Health*, **99**, 929-935.

Dykes F. & Flacking R. (2010) Encouraging breastfeeding: A relational perspective. *Early Human Development*, **86**, 733-736

Dyson L., Green J.M., Renfrew M.J., McMillan B., & Woolridge M. (2010) Factors Influencing the infant feeding decision for socioeconomically deprived pregnant teenagers: The moral dimension. *Birth*, **37**, 141-149.

Foster E.M. (2010) The u-shaped relationship between complexity and usefulness: A commentary. *Developmental Psychology*, **46**, 1760-1766.

Forster D.A. & McLachlan H.L. (2010) Women's views and experiences of breast feeding: Positive, negative or just good for the baby? *Midwifery*, **26**, 16-125.

Grummer-Strawn L.M., Scanlon K.S., & Fein S.B. (2008) Infant feeding and feeding transitions during the first year of life. *Pediatrics*, **122**, S36-S42.

Haig D. (1993) Genetic conflicts in human pregnancy. *Quarterly Review of Biology*, **68**, 495-532.

Haig D. (2008) Intimate relations: Evolutionary conflicts of pregnancy and childhood. In *Evolution in Health and Disease,* 2nd edn. (eds. S.C. Stearns & J. Koella), pp. 65-76. Oxford University Press: Oxford.

Hauck F.R., Thompson J.M., Tanabe K.O., Moon R.Y., & Vennemann M.M. (2011) Breastfeeding and reduced risk of sudden infant death syndrome: A meta-analysis. *Pediatrics*, doi: 10.1542/peds.2010-3000.

Hector D., King L., Webb K., & Heywood P. (2005) Factors affecting breastfeeding practices: Applying a conceptual framework. *NSW Public Health Bulletin*, **16**, 52-55.

Hodges E.A., Hughes S.O., Hopkinson J., & Fisher J.O. (2008) Maternal decisions about the initiation and termination of infant feeding. A*ppetite*, **50**, 333-339.

Horta B.L., Bahln R., Martines J.C., & Victora C.G. (2007) *Evidence on the Long-Term*

Effects of Breastfeeding: Systematic Reviews and Meta-Analyses. World Health Organization: Geneva. Available at http://whqlibdoc.who.int/publications/2007/9789241595230_eng.pdf

Howard C.R., Lanphear N., Lanphear B.P., Eberly S., & Lawrence R.A. (2006) Parental responses to infant crying and colic: The effect on breastfeeding duration. *Breastfeeding Medicine*, **1**, 146-155.

Jasienska G. (2009) Reproduction and lifespan: Trade-offs, overall energy budgets, intergenerational costs, and costs neglected by research. *American Journal of Human Biology*, **21**, 524-532.

Labbok M.H. (2008) Transdisciplinary breastfeeding support: Creating program and policy synergy across the reproductive continuum. *International Breastfeeding Journal*, **3**, 16.

Labbok M.H. (2001) Effects of breastfeeding on the mother. *Pediatric Clinics of North America*, **48**, 143-158.

Labbok M.H., Clark D., & Goldman A.S. (2004) Breastfeeding: Maintaining an irreplaceable immunological resource. *Nature Reviews: Immunology*, **4**, 565-572.

Lavender T., Baker L., Smyth R., Collins S., Spofforth A., & Dey P. (2005) Breastfeeding expectations versus reality: A cluster randomised controlled trial. *BJOG: An International Journal of Obstetrics and Gynaecology*, **112**, 1047-1053.

Lavender T., McFadden C., & Baker L. (2006) Breastfeeding and family life. *Maternal & Child Nutrition,* **2**, 145-155.

Lawrence R.A., & Lawrence R.M. (2005) *Breastfeeding: A Guide for the Medical Profession*, 6th edn. Elsevier Mosby: Philadelphia.

Lerner R.M., Theokas C., & Bobek D.L. (2005) Concepts and theories of human development: Historical and contemporary dimensions. In: *Developmental Science: An Advanced Textbook*, 5th edn. (eds. M.H. Bornstein & M.E. Lamb), pp. 3-49. Lawrence Erlbaum Associates: Mahwah.

MacGregor E., & Hughes M. (2010) Breastfeeding experiences of mothers from disadvantaged groups: A review. *Community Practitioner*, **83**, 30-33.

Magnusson D. 1988. *Individual Development from an Interactional Perspective: A Longitudinal Study*. Lawrence Erlbaum Associates: Hillsdale.

Magnusson D. & Cairns R.B. (1996) Developmental science: Toward a unified framework. In: *Developmental Science* (eds. R. B. Cairns, G.H. Elder & E.J. Costello), pp. 7-30. Cambridge University Press: Cambridge.

Martens P.J., & Young T.K. (1997) Determinants of breastfeeding in four Canadian Ojibwa communities: A decision-making model. *American Journal of Human Biology*, **9**, 579-593.

McDade T.W. & Worthman C.M. (1998) The weanling's dilemma reconsidered: A biocultural analysis of breastfeeding ecology. *Developmental & Behavioral Pediatrics*, **19**, 286-299.

McQueen K.A., Dennis C.L., Stremler R., & Norman C. (2011) A pilot randomized controlled trial of a breastfeeding intervention with primiparous mothers. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, **40**, 35-46.

Mentro A.M., Steward D.K., & Garvin B.J. (2002) Infant feeding responsiveness: A conceptual analysis. *Journal of Advanced Nursing*, **37**, 208-216.

Merten S., Dratva J., & Ackermann-Liebrich U. (2005) Do Baby-Friendly hospitals influence breastfeeding duration on a national level? *Pediatric*s, **116**, e702-2708.

Mizuno K., Fujimaki K., & Sawada M. (2004) Suckling behavior at breast during the early newborn period affects later breast-feeding rate and duration of breast-feeding. *Pediatrics International*, **46**, 15-20.

Nelson A.M. (2006) Toward a situation-specific theory of breastfeeding. *Research and Theory for Nursing Practice: An International Journal*, **20**, 9-27.

Nommsen-Rivers L.A., Chantry C.J., Cohen R.J., & Dewey K.G. (2010a) Comfort with the idea of formula feeding helps explain ethnic disparity in breastfeeding intentions among expectant first-time mothers. *Breastfeeding Medicine*, **5**, 25-33.

Nommsen-Rivers L.A., Cohen, R.J., Chantry C.J., & Dewey K.G. (2010b) The Infant Feeding Intentions scale demonstrates construct validity and comparability in quantifying maternal breastfeeding intentions across multiple ethnic groups. *Maternal & Child Nutrition*, **6**, 220-227.

Pearson R.M., Lightman S.L., & Evans J. (2011) The impact of breastfeeding on mothers' attentional sensitivity towards infant distress. *Infant Behavior & Development*, **34**, 200-205.

Reiches M.W., Ellison P.T., Lipson S.F., Sharrock K.C., Gardiner E., & Duncan L.G. (2009) Pooled energy budget and human life history. *American Journal of Human Biology*. **21**, 421-429.

Rempel L.A. & Rempel J.K. (2010) The breastfeeding team: The role of involved fathers in the breastfeeding family. *Journal of Human Lactation*, **27**, 115-121.

373 Rothman A.J. (2000) Toward a theory-based analysis of behavioral maintenance. *Health*
374 *Psychology*, **19**, 64-69.
375 Sadeh A., Mindell J., & Rivera L. (2011) “My child has a sleep problem”: A cross-cultural
376 comparison of parental definitions. *Sleep Medicine*, **12**, 478-482.
377 Salehnejad R. (2007) *Rationality, Bounded Rationality and Microfoundations: Foundations of*
378 *Theoretical Economics*. Palgrave MacMillan: New York.
379 Scheper-Hughes N. (1992) *Death Without Weeping: The Violence of Everyday Life in Brazil*.
380 University of California Press: Berkeley.
381 Sellen D.W. (2007) Evolution of infant and young child feeding: Implications for contemporary
382 public health. *Annual Review of Nutrition*, **27**, 123-148.
383 Sheehan A., Schmied V., & Barclay L. (2010) Complex decisions: Theorizing women’s
384 infant feeding decisions in the first 6 weeks after birth. *Journal of Advanced Nursing*,
385 **66**, 371-380.
386 Sloman J. & Wride A. (2009) *Economics*, 7th edn. Pearson Education Limited: Harlow.
387 Stuebe A.M. & Schwarz E.B. (2010) The risks and benefits of infant feeding practices for
388 women and their children. *Journal of Perinatology*, **30**, 155-162.
389 Strassman B.I. & Mace R. (2008) Perspectives on human health and disease from
390 evolutionary and behavioural ecology. In: *Evolution in Health and Disease*, 2nd edn.
391 (eds. S.C. Stearns & J. Koella), pp. 109-122. Oxford University Press: Oxford.
392 Stewart-Knox B., Gardiner K., & Wright M. (2003) What is the problem with breast-feeding?
393 A qualitative analysis of infant feeding perceptions. *Journal of Human Nutrition and*
394 *Dietetics*, **16**, 265-273.
395 Tiedje L.B., Schiffman R., Omar M., Wright J., Buzzitta C., McCann A. *et al*. (2002) An
396 ecological approach to breastfeeding. *MCN: The American Journal of Maternal Child*
397 *Nursing*, **27**, 154-161.
398 Tikotzky L., De Marcas G., Har-Toov J., Dollberg S., Bar-Haim Y., & Sadeh A. (2010)
399 Sleep and physical grown in infants during the first 6 months. *Journal of Sleep*
400 *Research*, **19**, 103-11.
401 Tracer D.P. (2009) Breastfeeding structure as a test of parental investment theory in Papua
402 New Guinea. *American Journal of Human Biology*, **21**, 635-642.
403 Trivers R.L. (1974) Parent-offspring conflict. *American Zoologist,* **14**, 249-264.
404 Valeggia C. & Ellison P.T. (2009) Interactions between metabolic and reproductive functions

405 in the resumption of postpartum fecundity. *American Journal of Human Biology*, **21**,
406 559-566.
407 Vitzthum V.J. (2008) Evolutionary models of women's reproductive functioning. *Annual*
408 *Review of Anthropology*, **37**, 53-73.
409 Winberg J. (2005) Mother and newborn baby: Mutual regulation of physiology and behavior –
410 A selective review. *Developmental Psychobiology*, **47**, 217-229.
411 Wojcicki J.M., Gugig R., Tran C., Suganya K., Holbrook K., & Heyman M.B. (2010) Early
412 exclusive breastfeeding and maternal attitudes towards infant feeding in a population
413 of new mothers in San Francisco, California. *Breastfeeding Medicine*, **5**, 9-15.
414 World Health Organization (2009) *Acceptable Medical Reasons for Breast-Milk Substitutes*.
415 World Health Organization: Geneva. Available at
416 http://www.who.int/child_adolescent_health/documents/WHO_FCH_CAH_09.01/en/
417 World Health Organization (2010) *Indicators for Assessing Infant and Young Child Feeding*
418 *Practices. Part 3: Country profiles*. World Health Organization: Geneva. Available at
419 http://whqlibdoc.who.int/publications/2010/9789241599757_eng.pdf
420 Worthman C.M. & Kuzara J. (2005) Life history and the early origins of health differentials.
421 *American Journal of Human Biology*, **17**, 95-112.
422

Figure 1: Theoretical mother-infant breastfeeding trade-offs over a specific period of time (expanded from Trivers, 1974).